



(11)

EP 2 453 549 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
16.05.2012 Bulletin 2012/20

(51) Int Cl.:
H02K 1/27 (2006.01)

(21) Application number: **10191046.1**

(22) Date of filing: 12.11.2010

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO
PL PT RO RS SE SI SK SM TR
 Designated Extension States:
BA ME

- **Valtonen, Mikko Nestor**
45100 Kouvola (FI)
- **Naumanen, Ville Juhani**
54410 Ylämaa (FI)
- **Rauma, Kommo Tapio**
53850 Lappeenranta (FI)

(71) Applicant: **Visedo Oy**
53850 Lappeenranta (FI)

(74) Representative: **Väänänen, Janne Kalervo**
Berggren Oy Ab
P.O. Box 16
Antinkatu 3 C
FI-00101 Helsinki (FI)

(72) Inventors:
• **Pyrhönen, Juha, Jaakko**
53850 Lappeenranta (FI)

(54) **A permanent magnet rotor for an axial flux electrical machine of a mobile working machine**

(57) A permanent magnet rotor (101) for an axial flux electrical machine of a mobile working machine comprises a shaft (102), a body (103) made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules (104) attached to the body and having an axis of magnetization in an axial direction (z) parallel to the shaft. The permanent magnet pole-modules comprise, at least on their outmost regions in the axial direction, structures (105, 107) consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction. Losses caused by the air-gap flux harmonics are reduced because the body of the rotor is made of electrically non-conductive material and because the permanent magnet pole-modules comprise the structures consisting of parts that are electrically insulated from each other.

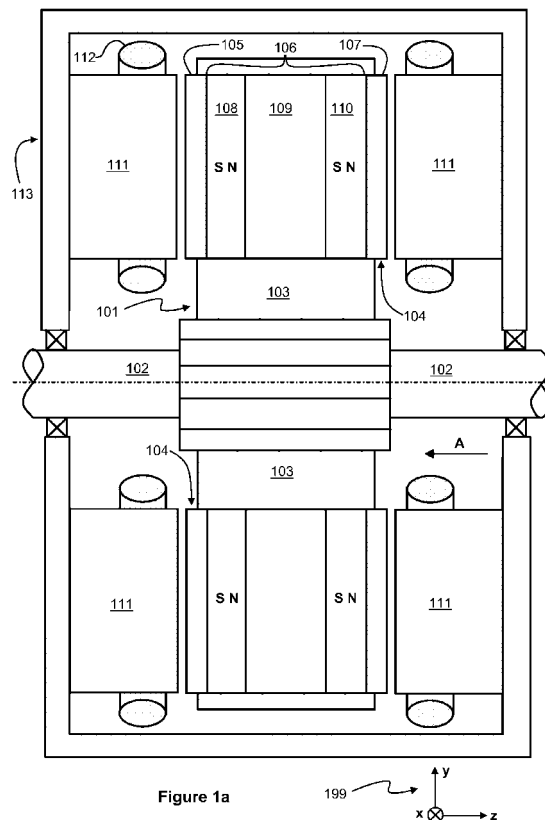


Figure 1a

199 

Description

Field of the invention

[0001] The invention relates generally to rotating electrical machines. More particularly, the invention relates to a permanent magnet rotor for an axial flux electrical machine of a mobile working machine. Furthermore, the invention relates to an axial flux electrical machine for a mobile working machine. Furthermore, the invention relates to a mobile working machine.

Background

[0002] Rotating electrical machines, such as motors and generators, generally comprise a rotor and a stator which are arranged such that a magnetic flux is developed between these two. In a permanent magnet ("PM") electrical machine, a number of permanent magnets are usually mounted on the rotor, while the stator is provided with stator windings. The permanent magnets and electrical currents in the stator windings cause a magnetic flux to flow across the air gap between the rotor and the stator.

[0003] An axial flux electrical machine is advantageous especially in applications in which the axial length of the electrical machine should be as small as possible. A permanent magnet rotor of an axial flux electrical machine comprises typically a shaft, a body connected to the shaft, and permanent magnet pole-modules each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft. The stator of the axial flux electrical machine comprises typically, but not necessarily, two stator elements that are opposed to each other with the permanent magnet rotor interposed therebetween. Each coil of the stator winding has a magnetic axis directed axially parallel to the shaft of the permanent magnet rotor.

[0004] In order to minimize the hysteresis and eddy current losses in the permanent magnets of the rotor, the stator should produce as little as possible such components of the air-gap magnetic flux distribution which do not travel at the synchronous speed, i.e. at the speed of the air-gap surface of the rotor. As commonly known, the above-mentioned harmful components of the air-gap magnetic flux distribution are attempted to be minimized by using stator windings which are distributed into a plurality of stator slots per pole per phase. A stator having distributed stator windings of the kind mentioned above is however more complex and expensive to manufacture than a stator having simple concentrated stator windings where each coil is located around a salient stator pole.

Summary

[0005] The following presents a simplified summary in order to provide a basic understanding of some aspects of various invention embodiments. The summary is not

an extensive overview of the invention. It is neither intended to identify key or critical elements of the invention nor to delineate the scope of the invention. The following summary merely presents some concepts of the invention in a simplified form as a prelude to a more detailed description of exemplifying embodiments of the invention.

[0006] In accordance with the first aspect of the invention, there is provided a new permanent magnet rotor for an axial flux electrical machine of a mobile working machine. The permanent magnet rotor comprises:

- a shaft,
- a body made of electrically non-conductive material and connected to the shaft, and
- permanent magnet pole-modules each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft,

wherein the permanent magnet pole-modules comprise, at least in their outmost regions in the axial direction, structures consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction.

[0007] In a permanent magnet rotor according to an advantageous embodiment of the invention, each of the permanent magnet pole-modules comprises a first ferromagnetic layer, a permanent magnet core-part, and a second ferromagnetic layer sandwiched in the axial direction so that the permanent magnet core-part is between the first and second ferromagnetic layers, and the first and second ferromagnetic layers comprise ferromagnetic parts that are electrically insulated from each other. In this case, the first and the second ferromagnetic layers represent the structures consisting of parts that are electrically insulated from each other.

[0008] The above-described permanent magnet rotor is suitable for an axial flux electrical machine which includes concentrated stator windings so that each stator coil is located around a salient pole of a stator core. The salient poles of the stator cause relatively strong harmonics to the magnetic flux density distribution in the air-gap, but the losses caused by these harmonics are reduced because the body of the rotor is made of electrically non-conductive material and because, from the viewpoint of the harmonics, the permanent magnets are located behind the first and second ferromagnetic layers made of parts that are electrically insulated from each other. The first and second ferromagnetic layers can be, for example, stacks of insulated steel sheets which are stacked in a direction perpendicular to the shaft of the permanent magnet rotor, or the first and second ferromagnetic layers can be made of, for example, ferrite, or block of iron powder composite.

[0009] In a permanent magnet rotor according to another embodiment of the invention, permanent magnets

of the permanent magnet pole-modules are composed of electrically insulated pieces of permanent magnet material stacked in a direction perpendicular to the shaft. In this case, the permanent magnets represent the structures consisting of parts that are electrically insulated from each other. Also a permanent magnet rotor of this kind is suitable for an axial flux electrical machine which includes concentrated stator windings so that each stator coil is located around a salient pole of a stator core, because permanent magnets composed of electrically insulated pieces of permanent magnet material are not so vulnerable to air-gap flux harmonics as monolithic permanent magnets.

[0010] In accordance with the second aspect of the invention, there is provided a new axial flux electrical machine for a mobile working machine. The axial flux electrical machine comprises:

- a permanent magnet rotor comprising a shaft, a body made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft, and
- a stator having a stator core and concentrated stator windings each coil of which being located around a stator pole and having a magnetic axis directed axially parallel to the shaft of the permanent magnet rotor,

wherein the permanent magnet pole-modules comprise, at least in their outmost regions in the axial direction, structures consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction.

[0011] In accordance with the third aspect of the invention, there is provided a new mobile working machine. The mobile working machine comprises:

- a combustion engine, and
- an electromechanical power transmission chain between the combustion engine and one or more wheels of the mobile working machine,

wherein the electromechanical transmission chain comprises at least one axial flux electrical machine that comprises:

- a permanent magnet rotor comprising a shaft, a body made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft, and

- a stator having concentrated stator windings each coil of which being located around a stator pole and having a magnetic axis directed axially parallel to the shaft of the permanent magnet rotor,

wherein the permanent magnet pole-modules comprise, at least in their outmost regions in the axial direction, structures consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction.

[0012] The mobile working machine comprises preferably a liquid cooling system arranged to cool both a hydraulic system of the mobile working machine and the electromechanical power transmission chain. The mobile working machine can be, for example, a tractor, a bucket charger, a road drag, a bulldozer, or any other working machine having wheels and/or chain tracks.

[0013] A number of exemplifying embodiments of the invention are described in accompanied dependent claims.

[0014] Various exemplifying embodiments of the invention both as to constructions and to methods of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific exemplifying embodiments when read in connection with the accompanying drawings.

[0015] The verb "to comprise" is used in this document as an open limitation that neither excludes nor requires the existence of unrecited features. The features recited in depending claims are mutually freely combinable unless otherwise explicitly stated.

Brief description of the figures

[0016] The exemplifying embodiments of the invention and their advantages are explained in greater detail below in the sense of examples and with reference to the accompanying drawings, in which:

figure 1a shows a section view of an axial flux electrical machine according to an embodiment of the invention,

figure 1b shows a permanent magnet rotor according to an embodiment of the invention seen from the axial direction,

figure 2 shows a section view of an axial flux electrical machine according to an embodiment of the invention, and

figure 3 shows an illustration of a mobile working machine according to an embodiment of the invention.

Description of the embodiments

[0017] Figure 1 a shows a section view of an axial flux

electrical machine according to an exemplifying embodiment of the invention. In figure 1a, the positive and negative z-directions of a coordinate system 199 represent the axial direction. The axial flux electrical machine comprises a stator 113 and a permanent magnet rotor 101. The stator comprises a stator core 111 and concentrated stator windings 112. Each coil of the stator windings is located around a salient stator pole and has an axially directed magnetic axis. Figure 1b shows the permanent magnet rotor 101 seen along the arrow A shown in figure 1 a. The permanent magnet rotor 101 comprises a shaft 102, a body 103 made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules 104 attached to the body. Each of the permanent magnet pole-modules 104 has an axis of magnetization in the positive or negative z-direction parallel to the shaft 102. The body 103 can be made of, for example, fiber reinforced plastics. Each of the permanent magnet pole-modules comprises a first ferromagnetic layer 105, a permanent magnet core-part 106, and a second ferromagnetic layer 107 sandwiched in the axial direction so that the permanent magnet core-part is between the first and second ferromagnetic layers. In figures 1 a and 1 b "N" means the north poles of the permanent magnets and "S" means the south poles of the permanent magnets. The first and second ferromagnetic layers 105 and 107 are composed of ferromagnetic parts that are electrically insulated from each other in order to reduce eddy currents caused by magnetic flux variations in the first and second ferromagnetic layers. The first and second ferromagnetic layers 105 and 107 can be, for example, stacks of insulated steel sheets which are stacked in a direction perpendicular to the shaft. In the exemplifying case shown in figures 1 a and 1 b, the insulated steel sheets are stacked in the radial direction but, as well, the insulated steel sheets could be stacked for example in the tangential direction. Furthermore, the first and second ferromagnetic layers 105 and 107 can be made of ferrite or iron powder composites such as SOMALLOY® (Soft Magnetic Composite). The salient poles of the stator core 111 cause relatively strong harmonics to the magnetic flux density distribution in the air-gap between the stator and the rotor, but the losses caused by these harmonics are reduced because the body of the rotor is made of electrically non-conductive material and because, from the viewpoint of the harmonics, the permanent magnets are located behind the first and second ferromagnetic layers made of parts that are electrically insulated from each other.

[0018] In a permanent magnet rotor according to an embodiment of the invention, the permanent magnet core-part 106 comprises a first block 108 made of permanent magnet material, a ferromagnetic center block 109, and a second block 110 made of the permanent magnet material. These blocks are sandwiched in the axial direction so that the ferromagnetic center block is between the first and second blocks made of the permanent magnet material. The ferromagnetic center block

109 can be made of, for example, solid steel.

[0019] In a permanent magnet rotor according to an embodiment of the invention, the axial thicknesses of the first and second ferromagnetic 105 and 107 layers are greater than or equal to 4 mm and advantageously on the range 4 - 8 mm.

[0020] The axial flux electrical machine shown in figure 1 a has two stator elements that are opposed to each other with the permanent magnet rotor interposed therebetween. It is also possible that an axial flux electrical machine according to an embodiment of the invention has a stator core only on one side of the rotor in which case the ferromagnetic layers covering the permanent magnet core-parts on the other side of the rotor are arranged to extend over several permanent magnet pole-modules so as to form yokes between the respective permanent magnet core-parts.

[0021] Figure 2 shows a section view of an axial flux electrical machine according to an exemplifying embodiment of the invention. In figure 2, the positive and negative z-directions of a coordinate system 299 represent the axial direction. Only an upper half of the electrical machine is shown in figure 2. The axial flux electrical machine comprises a stator 213 and a permanent magnet rotor 201. The stator comprises a stator core 211 and concentrated stator windings 212. Each coil of the stator windings is located around a salient stator pole and has an axially directed magnetic axis. The permanent magnet rotor 201 comprises a shaft 202, a body 203 made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules 204 attached to the body. Each of the permanent magnet pole-modules 204 has an axis of magnetization in the positive or negative z-direction parallel to the shaft 202. The body 203 can be made of, for example, fiber reinforced plastics. Each of the permanent magnet pole-modules comprises permanent magnets 208 and 210, and a ferromagnetic center block 209. In figure 2 "N" means the north poles of the permanent magnets and "S" means the south poles of the permanent magnets. The permanent magnets 208 and 209 are composed of pieces of permanent magnet material that are electrically insulated from each other in order to reduce eddy currents caused by magnetic flux variations in the permanent magnets. The permanent magnets 208 and 209 can be, for example, stacks of insulated slices of permanent magnet material which are stacked in a direction perpendicular to the shaft. In the exemplifying case shown in figure 2, the insulated slices are stacked in the radial direction but, as well, the insulated slices could be stacked for example in the tangential direction. The salient poles of the stator core 211 cause relatively strong harmonics to the magnetic flux density distribution in the air-gap between the stator and the rotor, but the losses caused by these harmonics are reduced because the body of the rotor is made of electrically non-conductive material and because the permanent magnets are composed of insulated pieces of permanent magnet material.

[0022] In the exemplifying embodiment of the invention illustrated in figure 2, the body 203 and the permanent magnet pole-modules 204 are shaped so as to lock the permanent magnet pole-modules to the body. In this exemplifying case, the body comprises closed cavities for the permanent magnet pole-modules. However, many different shapes are possible for obtaining the locking effect. The body can be composed of two halves that are joined together in the axial direction, or alternatively the body can be cast around the permanent magnet pole-modules.

[0023] The axial flux electrical machine shown in figure 2 has two stator elements that are opposed to each other with the permanent magnet rotor interposed therebetween. It is also possible that there is a stator core only on one side of the rotor in which case the rotor comprises yokes between relevant permanent magnet pole-modules on the other side.

[0024] Figure 3 shows an illustration of a mobile working machine 320 according to an embodiment of the invention. In this exemplifying case, the mobile working machine is a bucket charger but the mobile working machine could as well be a tractor, a road drag, a bulldozer, or any other working machine having wheels and/or chain tracks. The mobile working machine comprises a combustion engine 321 that can be e.g. a diesel engine, an Otto-cycle engine, or a turbine engine. The mobile working machine comprises an electromechanical power transmission chain 322 between the combustion engine and wheels 330, 331 of the mobile working machine. The electromechanical transmission chain comprises a generator 323 the rotor of which is connected to the shaft of the combustion engine. The electromechanical transmission chain comprises a frequency converter 329 and electrical motors 324, 325 at the hubs of the wheels of the mobile working machine. The frequency converter 329 is arranged to convert the electrical voltage produced by the generator 323 into electrical voltages having amplitudes and frequencies suitable for the electrical motors 324, 325. The frequency converter may have separate output stages for all the electrical motors 324, 325 in which case each electrical motor can be controlled individually, or all the electrical motors 324, 325 can be connected to one and the same output stage of the frequency converter in which case the electrical motors are controlled as a group. The electrical motors 324, 325 are axial flux electrical machines each of which comprises:

- a rotor comprising a shaft, a body made of electrically non-conductive material and connected to the shaft, and permanent magnet pole-modules each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft, and
- a stator having concentrated stator windings each coil of which being located around a salient stator pole and having a magnetic axis directed axially par-

allel to the shaft of the rotor.

[0025] The permanent magnet pole-modules of the rotor comprise, at least in their outmost regions in the axial direction, structures consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction. For example, each permanent magnet pole-module may comprise a first ferromagnetic layer, a permanent magnet core-part, and a second ferromagnetic layer sandwiched in the axial direction so that the permanent magnet core-part is between the first and second ferromagnetic layers, where the first and second ferromagnetic layers comprise ferromagnetic parts that are electrically insulated from each other. For another example, permanent magnets of the permanent magnet pole-modules can be composed of electrically insulated pieces of permanent magnet material stacked in a direction perpendicular to the shaft, in which case the permanent magnets represent the structures consisting of parts that are electrically insulated from each other.

[0026] In a mobile working machine according to an embodiment of the invention, also the generator 323 is an axial flux electrical machine of the kind described above. It is also possible that only the generator 323 is an axial flux electrical machine of the kind described above, and the electrical motors 324, 325 are electrical machines of some other kind.

[0027] A mobile working machine according to an embodiment of the invention comprises a liquid cooling system 326 arranged to cool the electromechanical power transmission chain 322.

[0028] A mobile working machine according to an embodiment of the invention comprises a liquid cooling system arranged to cool both a hydraulic system 327 of the mobile working machine and the electromechanical power transmission chain 322.

[0029] A mobile working machine according to an embodiment of the invention comprises a liquid cooling system arranged to cool both the electromechanical power transmission chain 322 and the combustion engine 321.

[0030] In a mobile working machine according to an embodiment of the invention, the electromechanical power transmission chain comprises a battery 328 arranged to respond to peak power needs exceeding the maximum power of the combustion engine 321. The battery can be connected, for example, to a direct voltage intermediate circuit of the frequency converter 329.

[0031] The specific examples provided in the description given above should not be construed as limiting. Therefore, the invention is not limited merely to the embodiments described above.

55 Claims

1. A permanent magnet rotor (101, 201) for an axial flux electrical machine of a mobile working machine,

the permanent magnet rotor comprising:

- a shaft (102, 202),
- a body (103, 203) connected to the shaft, and
- permanent magnet pole-modules (104, 204) each of which being attached to the body and having an axis of magnetization in an axial direction parallel to the shaft,

characterized in that the body is made of electrically non-conductive material, and the permanent magnet pole-modules comprise, at least in their outmost regions in the axial direction, structures consisting of parts that are electrically insulated from each other so as to reduce eddy currents in the outmost regions in the axial direction.

2. A permanent magnet rotor according to claim 1, wherein each of the permanent magnet pole-modules comprises a first ferromagnetic layer (105), a permanent magnet core-part (106), and a second ferromagnetic layer (107) sandwiched in the axial direction so that the permanent magnet core-part is between the first and second ferromagnetic layers, and the first and second ferromagnetic layers comprise ferromagnetic parts that are electrically insulated from each other, the first and the second ferromagnetic layers representing the structures consisting of parts that are electrically insulated from each other.
3. A permanent magnet rotor according to claim 2, wherein the first and second ferromagnetic layers are stacks of insulated steel sheets which are stacked in a direction perpendicular to the shaft.
4. A permanent magnet rotor according to claim 2, wherein the first and second ferromagnetic layers are made of iron powder composite.
5. A permanent magnet rotor according to claim 4, wherein the iron powder composite is ferrite.
6. A permanent magnet rotor according to any of claims 1-5, wherein the permanent magnet core-part comprises a first block (108) made of permanent magnet material, a ferromagnetic center block (109), and a second block (110) made of permanent magnet material sandwiched in the axial direction so that the ferromagnetic center block is between the first and second blocks.
7. A permanent magnet rotor according to any of claims 1-6, wherein axial thicknesses of the first and second ferromagnetic layers are at least 4 mm.
8. A permanent magnet rotor according to claim 1, wherein permanent magnets (208, 210) of the per-

manent magnet pole-modules are composed of electrically insulated pieces of permanent magnet material stacked in a direction perpendicular to the shaft, the permanent magnets representing the structures consisting of parts that are electrically insulated from each other.

9. A permanent magnet rotor according to any of claims 1-8, wherein the body (203) and the permanent magnet pole-modules (204) are shaped to lock the permanent magnet pole-modules to the body.
10. A permanent magnet rotor according to claim 9, wherein the body is composed of two halves joined together in the axial direction.
11. A permanent magnet rotor according to claim 9, wherein the body has been cast around the permanent magnet pole-modules.
12. An axial flux electrical machine for a mobile working machine, the axial flux electrical machine comprising:
 - a permanent magnet rotor (101) according to any of claims 1-11, and
 - a stator (113) having a stator core (111) and concentrated stator windings (112) each coil of which being located around a stator pole and having a magnetic axis directed axially parallel to the shaft of the permanent magnet rotor.
13. A mobile working machine (320) comprising:
 - a combustion engine (321), and
 - an electromechanical power transmission chain (322) between the combustion engine and one or more wheels (330, 331) of the mobile working machine,
 wherein the electromechanical transmission chain comprises at least one axial flux electrical machine (323-325) according to claim 12.
14. A mobile working machine according to claim 13, wherein the mobile working machine comprises a liquid cooling system (326) arranged to cool the electromechanical power transmission chain.
15. A mobile working machine according to claim 14, wherein the liquid cooling system is arranged to cool both the electromechanical power transmission chain and a hydraulic system (327) of the mobile working machine.
16. A mobile working machine according to claim 14, wherein the liquid cooling system is arranged to cool both the electromechanical power transmission

chain and the combustion engine.

17. A mobile working machine according to any of claims 13-16, wherein the electromechanical power transmission chain comprises a battery (328) arranged to respond to peak power needs exceeding the maximum power of the combustion engine.

10

15

20

25

30

35

40

45

50

55

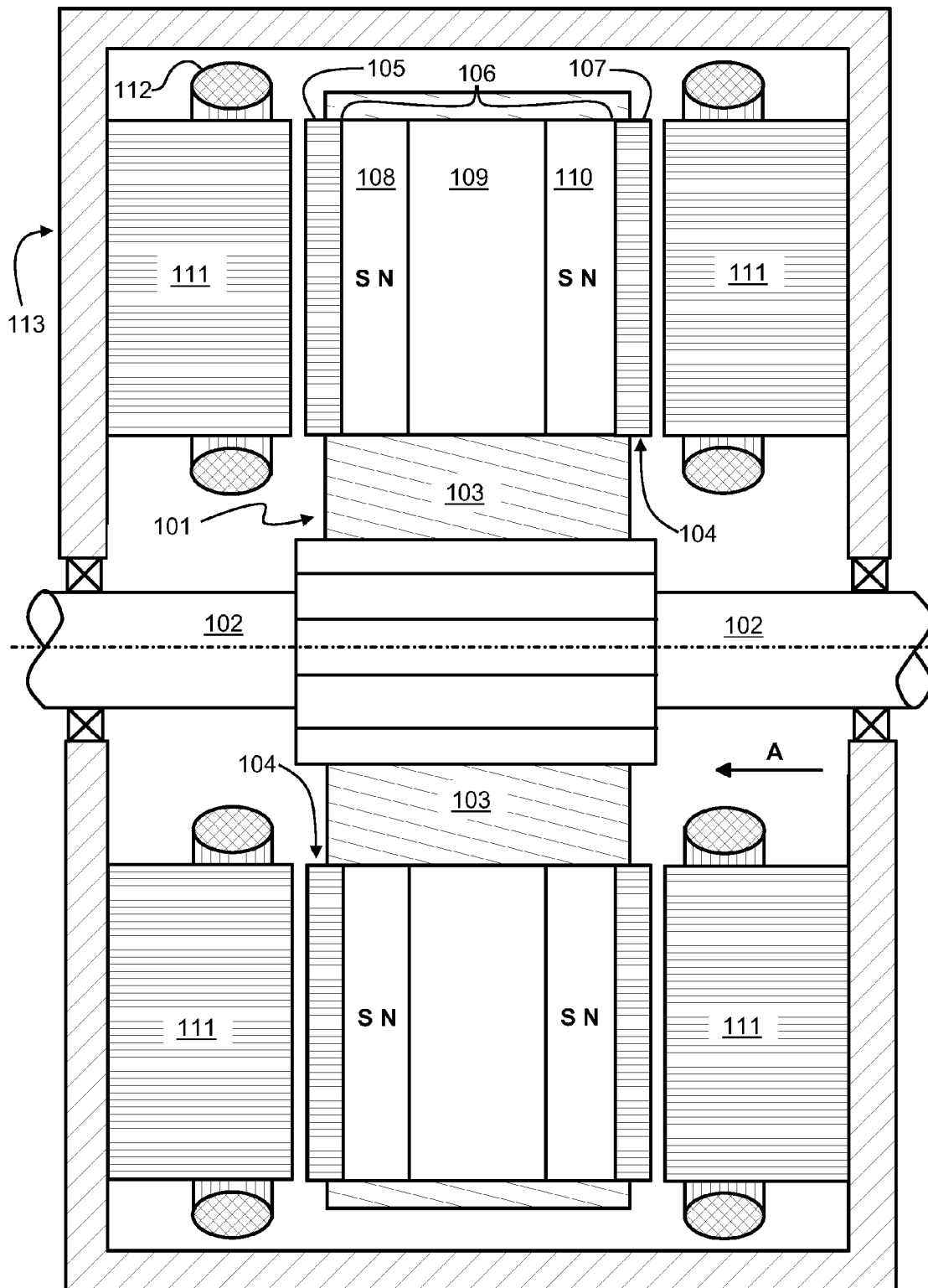
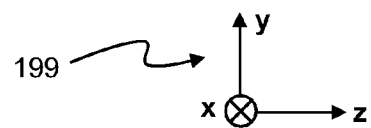


Figure 1a



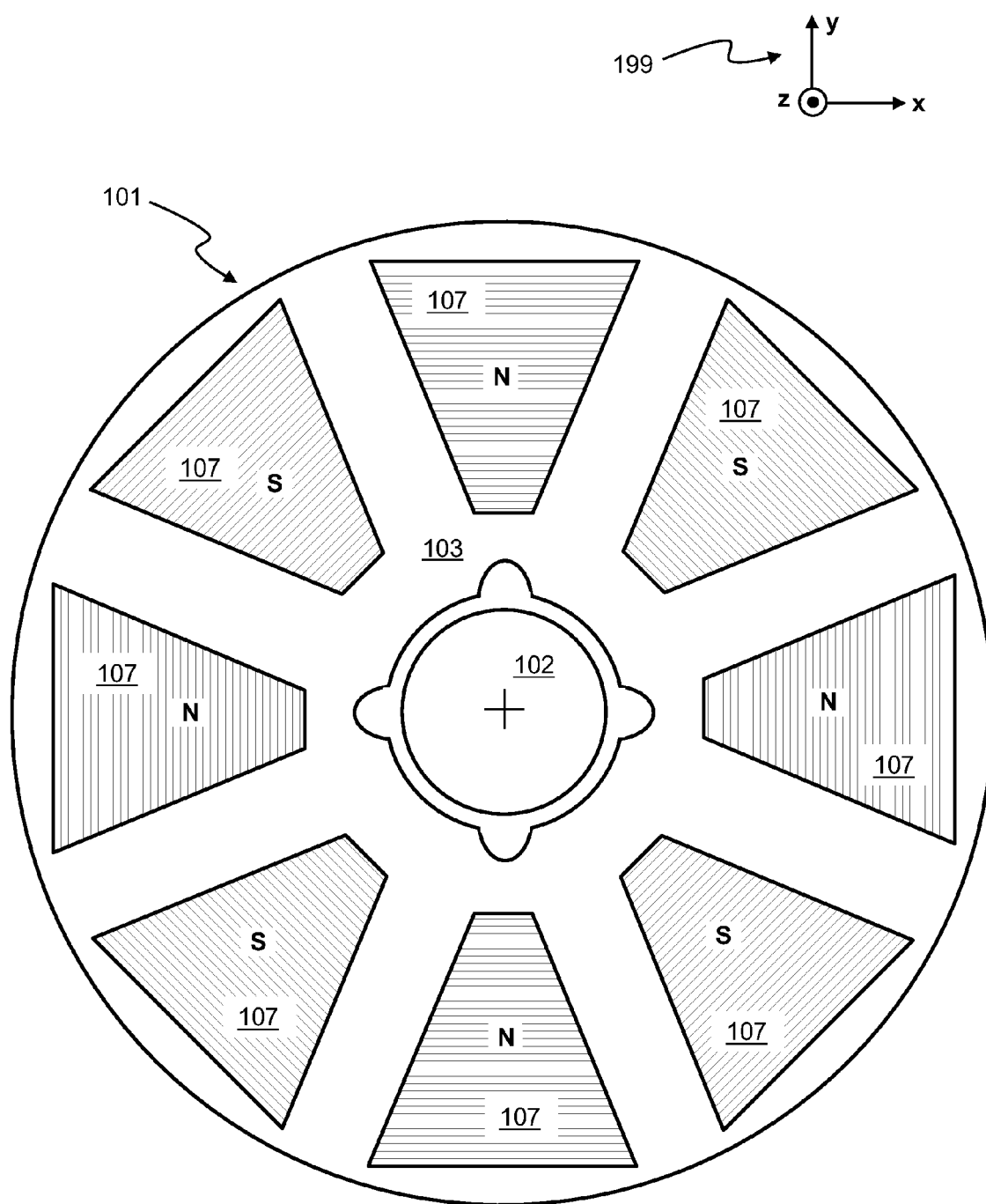


Figure 1b

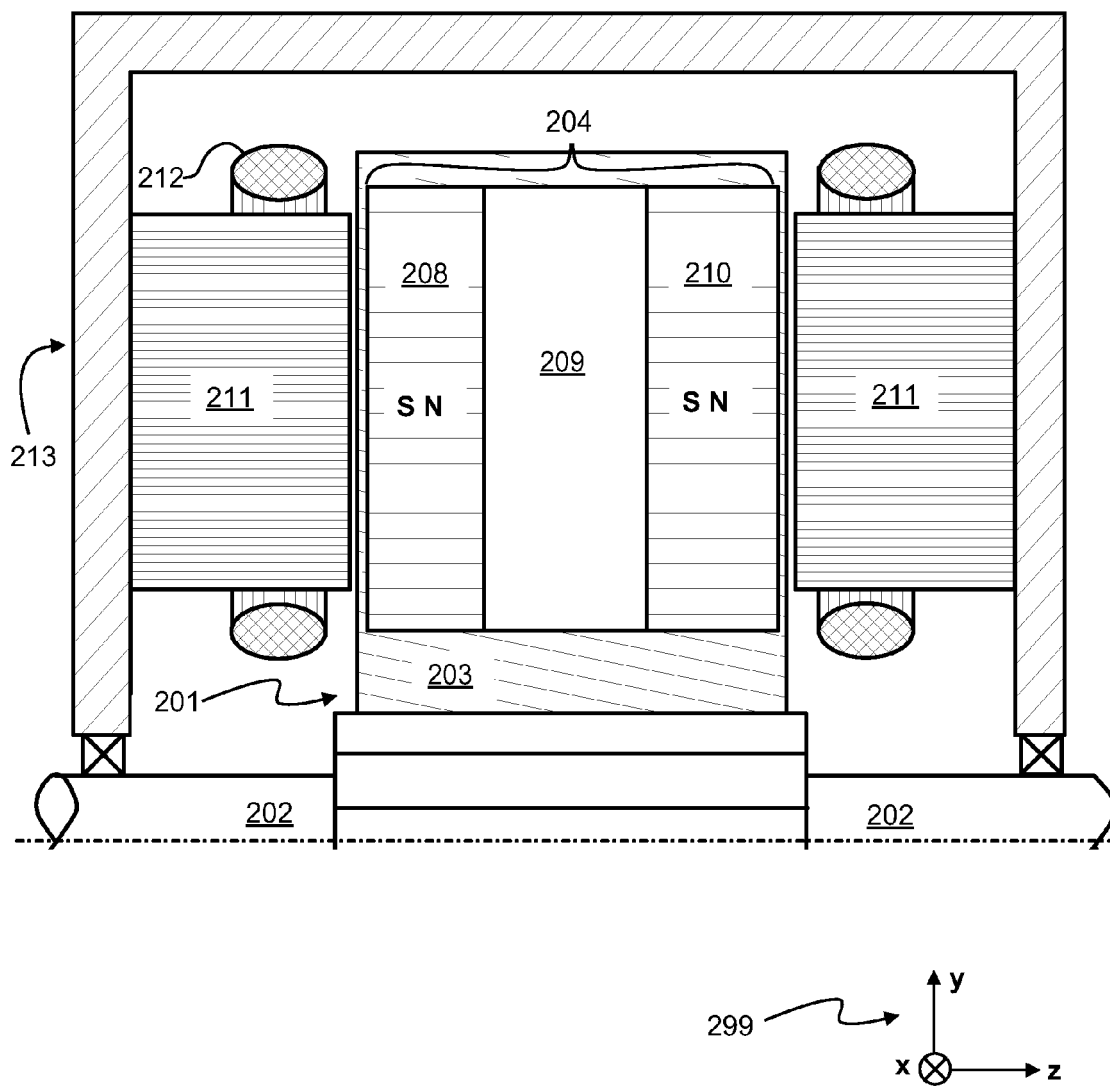


Figure 2

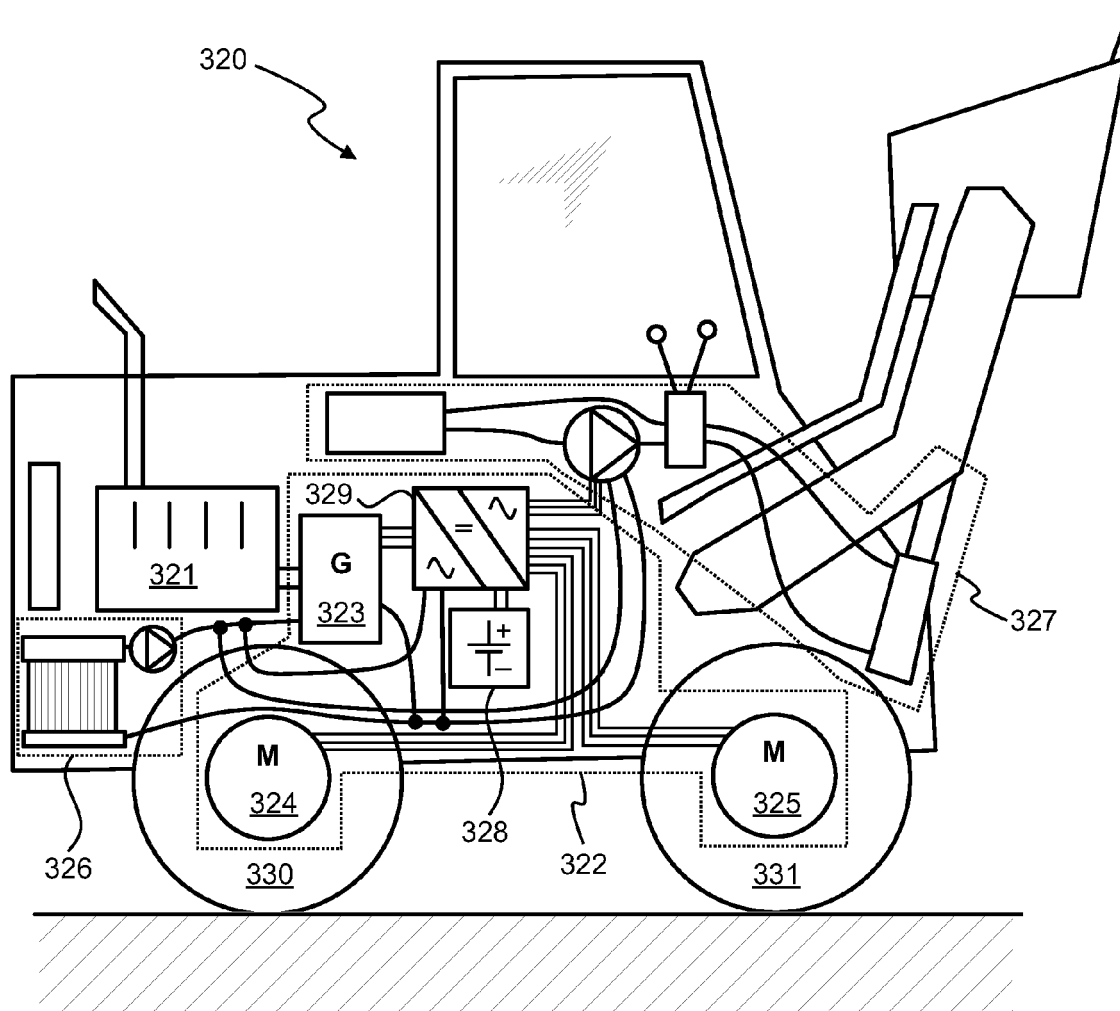


Figure 3



EUROPEAN SEARCH REPORT

Application Number
EP 10 19 1046

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	EP 2 066 004 A1 (DAIKIN IND LTD [JP]) 3 June 2009 (2009-06-03) * figures 2,3 * * paragraph [0068] * -----	1-10, 12-17	INV. H02K1/27
X	EP 2 043 231 A1 (DAIKIN IND LTD [JP]) 1 April 2009 (2009-04-01) * figure 8 * * paragraphs [0045], [0049], [0052] * -----	1-9, 11-17	
A	EP 1 612 913 A2 (NISSAN MOTOR [JP]) 4 January 2006 (2006-01-04) * figure 2 * * pages 32,33 * -----	3,6	
A	US 2009/295246 A1 (ABE SHOEI [JP]) 3 December 2009 (2009-12-03) * figures 1,3B,5B * * paragraph [0060] * -----	3	
A	WO 2008/142519 A1 (TOYOTA MOTOR CO LTD [JP]; TAKAHASHI TOSHIMITSU [JP]) 27 November 2008 (2008-11-27) * figures 7A,7B * * page 2 * -----	8	TECHNICAL FIELDS SEARCHED (IPC) H02K
A	JP 60 128853 A (TAKAHASHI Y; MITSUBISHI CHEM IND) 9 July 1985 (1985-07-09) * abstract * * figure 1 * -----	1	
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 20 May 2011	Examiner Le Chenadec, Hervé
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 3
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 19 1046

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

20-05-2011

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 2066004	A1	03-06-2009	AU 2007298344 A1	27-03-2008
			CN 101517860 A	26-08-2009
			JP 2008079362 A	03-04-2008
			WO 2008035599 A1	27-03-2008
			KR 20090027686 A	17-03-2009
			US 2009230811 A1	17-09-2009

EP 2043231	A1	01-04-2009	AU 2007273704 A1	17-01-2008
			CN 101454961 A	10-06-2009
			JP 4169055 B2	22-10-2008
			JP 2008022663 A	31-01-2008
			WO 2008007501 A1	17-01-2008
			KR 20090027657 A	17-03-2009
			US 2009273252 A1	05-11-2009

EP 1612913	A2	04-01-2006	CN 1716730 A	04-01-2006
			JP 4608967 B2	12-01-2011
			JP 2006014563 A	12-01-2006
			US 2005285467 A1	29-12-2005

US 2009295246	A1	03-12-2009	NONE	

WO 2008142519	A1	27-11-2008	CN 101689772 A	31-03-2010
			DE 112008001246 T5	04-03-2010
			JP 4241855 B2	18-03-2009
			JP 2008295165 A	04-12-2008
			US 2010013338 A1	21-01-2010

JP 60128853	A	09-07-1985	NONE	
